Draft Blackwater Creek, WBID 1482, Florida

Dissolved Oxygen and BOD

Total Maximum Daily Load

Prepared by:
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Region 4
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United States
Environmental Protection
Agency

Region 4
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SUMMARY SHEET

Total Maximum Daily Load (TMDL)

1. **303(d) Listed Waterbody Information**
   State: Florida
   County: Hillsborough
   Major River Basin: Tampa Bay Basin (HUC 03100205)

Waterbody (List ID)	Listing Year	Impairment(s)	Pollutant(s)
Blackwater Creek (WBID 1482)	**1998**	**Dissolved Oxygen (DO)**	**Natural wetland DO consumption**
Blackwater Creek (WBID 1482)	**1998**	**Biochemical Oxygen Demand (BOD)**	**BOD**

2. TMDL Endpoints (i.e., Targets) for Class III Waters (fresh):
Dissolved Oxygen (DO) shall not be less than 5.0 milligrams/L. Normal daily and seasonal fluctuations above these levels shall be maintained.

3. Pollutant Allocations for WBID 1442 (No Reduction Required)

Pollutant	TMDL	WLA		LA	MOS
		Continuous	MS4		
Dissolved Oxygen (DO)	5.0 mg/l or 1204 kg/d	53 kg/d	0.0	1151 kg/d	implicit
Biochemical Oxygen Demand	554 kg/d	52.2 kg/d	0.0	452 kg/d	50 kg/d

4. **Endangered Species (yes or blank):**

5. **EPA Lead on TMDL (EPA or blank):** EPA

6. **TMDL Considers Point Source, Nonpoint Source, or both:** Both

7. **Major NPDES Discharges to surface waters addressed in EPA TMDLs:**

Facility Name	NPDES No.	Facility Type	Impacted Stream
Plant City Water Reclamation Facility	FL0026557	Domestic WTP	East Canal, Itchepackesassa Creek, Blackwater Creek
CSX Transportation	FL0032581	Contact Stormwater Runoff	Winston Creek, Itchepachesassa Creek, Blackwater Creek

INTRODUCTION

The U.S. Environmental Protection Agency is proposing this Total Maximum Daily Load (TMDL) for New River (WBID) as required by the 1999 Consent Decree in Florida Wildlife Federation, Inc., et al. v. Browner, et al., Northern District of Florida, Civil Action No. 4: 98CV356-WS. .

The U.S. Environmental Protection Agency (EPA) has analyzed the available data and information for this waterbody, and has determined that this waterbody is *likely* not meeting the State of Florida's applicable water quality standard for dissolved oxygen (DO) due to naturally-occurring conditions. If the waterbody is not meeting its applicable water quality standards due to natural conditions, a TMDL would not be necessary nor would it be required by the consent decree. Florida's water quality standards recognize that some deviations from water quality standards occur as the result of natural background conditions, that is, the condition of the water in the absence of man-induced alterations. Florida's water quality standards also set out how the State is to establish the appropriate criteria for an altered waterbody, that is, where it can be demonstrated that the deviations would occur in the absence of any human-induced discharges or alterations to the water body. For such altered waterbodies, the State may establish a site-specific alternative criteria, based upon a similar unaltered waterbody or on historical pre-alteration data.

However, the existing data and information does not provide certainty that the deviations from the DO water quality standard are naturally occurring. EPA is therefore fulfilling its court-ordered commitment by proposing a TMDL for this waterbody. The TMDL, as proposed, indicates that the existing water quality standard for DO is not attainable in this waterbody, and therefore, recommends that the State of Florida establish a site-specific criterion for DO for this waterbody.

PROBLEM DEFINITION

Blackwater Creek, WBID 1482 is on the 1998 303 (d) list for low dissolved oxygen, biochemical oxygen demand, and coliforms. This TMDL will address the DO and BOD impairment, and the other impairments will be covered by separate TMDL documents.

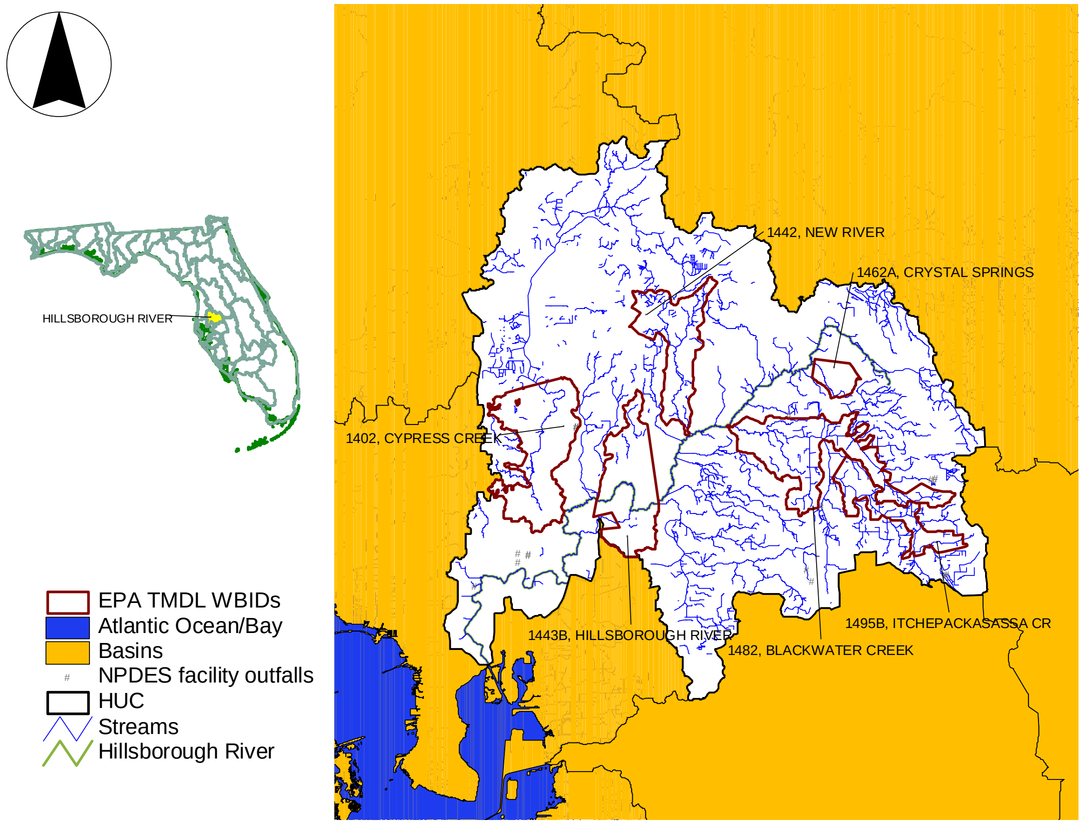


Figure 1: Tampa Bay Tributaries, Impaired WBIDs that EPA is addressing

WATERSHED DESCRIPTION

The FDEP Water Quality Assessment Report describes the Hillsborough River Basin which begins east-northeast of Zephyrhills and drains 690 square miles before emptying into the upper Hillsborough Bay, a part of Tampa Bay. Its headwaters originate in the southwestern portion of the Green Swamp, where it also receives overflow from the Withlacoochee River. The river channel is not clearly defined until the river leaves the swamp. From there, it flows southwesterly 54 miles through parts of Polk, Pasco, and Hillsborough Counties to upper Hillsborough Bay.

Perennially flowing tributaries to the Hillsborough River are Big Ditch and Flint Creek. Intermittent streams are Indian Creek, New River, Two Hole Branch, Basset Branch, Hollomans Branch, Clay Gully, Trout Creek, Blackwater Creek, and Cypress Creek. High floodwaters are diverted from the Hillsborough River at the confluence of Trout Creek and upstream of the Tampa Reservoir Dam through the Tampa Bypass Canal to McKay Bay.

Channelization has extended Sixmile Creek west and north to intersect the Hillsborough River at two points, the confluence of Trout Creek and near the midpoint of the Tampa Reservoir, which supplies drinking water to the city of Tampa. The modified Sixmile Creek was then renamed the Tampa Bypass Canal, which comprises two canals. The Harney Canal (C-136) runs from the Tampa Reservoir to join the second and longer canal, C-135, which connects the Hillsborough River at Trout Creek and Palm River. Both canals control flooding in the city of Tampa. Urban and built-up areas dominate the landscape in the southern quarter of the planning unit, which includes the urban and suburban areas of Tampa, Plant City, and Lakeland. In the upper half of the planning unit (to the north), urban and suburban areas appear as an east-west band encompassing Zephyrhills, Wesley Chapel, and Land O' Lakes. Together, urban and built-up lands comprise 25 percent of the total area. Within the region, which is characterized by expanding population growth and land development, large areas of swamps and forested uplands remain undeveloped along portions of the Hillsborough River and its principal tributaries. Together with other undeveloped lands, natural lands (uplands and wetlands) comprise 39 percent of the planning unit.

Throughout most of the rest of the planning unit, particularly in the upper reaches of its tributaries, land uses are primarily rangeland, pasture, and agriculture, including citrus groves and row crops. The greatest acreages of citrus are found around Land O' Lakes, in the Plant City/Dover/Seffner area south and east of Lake Thonotosassa, in the area around Lakeland, and in a wide area north of Zephyrhills. Generally, the northern and central portions of the watershed are rural, while the southern portions are mainly urban and industrial. However, suburban development radiating from major urban areas such as Tampa is spreading into rural areas.

Additional information about the river's hydrology and geology are available in the Basin Status Report for the Tampa Bay Tributaries Basin (Florida Department of Environmental Protection, 2003). For assessment purposes, the Florida Department of Environmental Protection (the Department) has divided the Tampa Bay Tributaries Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. The Hillsborough River has been divided into WBIDs or segments and this TMDL addresses Blackwater Creek, WBID 1482.

Several tributaries to the Hillsborough River are also impaired, such as Itchepackesassa Creek, Cow House Creek, and Crystal Springs. There are 127 permitted domestic and industrial facilities in the Hillsborough River planning unit. Urban land comprises 25 percent of the planning unit, natural lands comprise 39 percent, rangeland, pasture, and agriculture make up the rest of the planning unit.

Additionally, the Blackwater Creek and the Hillsborough River Basin are part of the Tampa Bay watershed for which a nitrogen management plan has been developed to protect and restore seagrasses in Tampa Bay. This plan implemented by the Tampa Bay Nitrogen Management Consortium (TBNMC) specifies target levels for nitrogen loading to the Tampa Bay at 1992-1994 levels. The TBNMC action plan includes stormwater treatment upgrades, conversion of septic systems to sewers, wastewater reuse, industrial retrofits, agricultural best management practices, land acquisition, and habitat restoration projects. Also, in 1980 all municipal wastewater treatment plants were required to provide Advanced Wastewater Treatment (AWT) for discharges directly to the bay and its tributaries.

WATER QUALITY STANDARD AND TARGET IDENTIFICATION

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	Potable water supplies
Class II	Shellfish propagation or harvesting
Class III	Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife
Class IV	Agricultural water supplies
Class V	Navigation, utility, and industrial use (there are no state waters currently in this class)

Waterbodies in the Hillsborough River Basin are classified as freshwater Class III waters, with a designated use classification for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters, are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria are as follows:

<u>Nutrients</u>

The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter [Section 62.302 F.A.C.] In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna [Section 62.302530 F.A.C.].

Dissolved Oxygen (DO)

Dissolved Oxygen (DO) shall not be less than 5.0 milligrams/L. Normal daily and seasonal fluctuations above these levels shall be maintained.

Biochemical Oxygen Demand (BOD)

BOD shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each Class and, in no case, shall it be great enough to produce nuisance conditions.

EXAMINE WATER QUALITY AND ENVIRONMENTAL DATA

The FDEP Water Quality Assessment Report describes that the status of surface water quality in the Tampa Bay Tributaries Basin was determined by evaluating three categories of data; chemistry data, biological data, and fish consumption advisories. The main source of water quality data was information collected between 1996 and 2003 and stored in the EPA's STOrage and RETrieval (STORET) database. Other sources included the FDEP's Biology Database (SBIO) and fish consumption advisory and beach closure information from DOH. In order to develop the TMDL, these data sources and all additional available data was used.

Ambient Water Quality Data

Biological data and chemical water quality data was assessed during the review and listing process. This data is summarized here as background information for the TMDL development. First, the biological data is discussed.

Blackwater Creek scored excellent and good on 1996 SCI, and an overall rating of healthy on the biorecon analysis, and considered not impaired under the FDEP bioassessment summary of all biological data.

Itchepackasassa Creek which flows into Blackwater Creek scored excellent and good on 1996 SCI and poor on one 1995 SCI sample. It was considered not impaired under the FDEP bioassessment summary for 5 of 6 sample events. Also, two other segments of this creek (WBIDs 1524 and 1495A) were considered healthy based on the 1996 sample data. (FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION, Division of Water Resource Management Basin Status Report, SOUTHWEST DISTRICT • GROUP 2 BASIN • JUNE 2002)

A list of biological assessment results from FDEP's IWR database is shown in Table 1. This shows that Blackwater Creek (WBID 1482) scored good to excellent in 1995 to 1999, then fell to poor in 2000.

Table 1: Biological Assessments for the 303(d) listed water bodies.(FDEP, IWR Database version 16_2, 2004)

WBID	Score	Method	Station ID	Station Name	Test Result	Date
1482	Excellent	SCI	BLCKWTER 4	Blackwater Creek adjacent to Cone Ranch	33	1/6/1997
1482	Excellent	SCI	BLCKWTER 5	Blackwater Creek adjacent to Cone Ranch	29	10/25/1999
1482	Healthy	BIORECON	TP40BLKWTR	BLKWTR CRK, ~0.5MI E OF CONFLUENCE W/ HILLS.R	3	3/6/1996
1482	Healthy	BIORECON	TP40BLKWTR	BLKWTR CRK, ~0.5MI E OF CONFLUENCE W/ HILLS.R	3	8/16/1995
1482	Excellent	SCI	BLCKWTER 5	Blackwater Creek adjacent to Cone Ranch	31	4/22/1996
1482	Excellent	SCI	BLCKWTER 4	Blackwater Creek adjacent to Cone Ranch	31	4/22/1996
1482	Excellent	SCI	AO1-BLKCK	Blackwater Ck, 700 ft upstream of Hwy 39 Bridge	31	10/21/1996
1482	Excellent	SCI	BLCKWTER 4	Blackwater Creek adjacent to Cone Ranch	29	7/15/1996
1482	Excellent	SCI	BLCKWTER 5	Blackwater Creek adjacent to Cone Ranch	33	1/6/1997
1482	Excellent	SCI	BLCKWTER 4	Blackwater Creek adjacent to Cone Ranch	29	10/14/1996
1482	Good	SCI	BLCKWTER 5	Blackwater Creek adjacent to Cone Ranch	23	7/15/1996
1482	Excellent	SCI	AO4-BLKCK	Blackwater Ck 20 ft above Deeson Rd deadend	27	10/21/1996
1482	Excellent	SCI	BLCKWTER 5	Blackwater Creek adjacent to Cone Ranch	29	1/25/2000
1482	Good	SCI	AO5-BLKCK	Blackwater Ck, 10 ft below Shady Oak Dr West	25	10/21/1996
1482	Excellent	SCI	BLCKWTER 5	Blackwater Creek adjacent to Cone Ranch	27	4/29/2000
1482	Excellent	SCI	BLCKWTER 5	Blackwater Creek adjacent to Cone Ranch	31	10/14/1996
1482	Excellent	SCI	BLCKWTER 4	Blackwater Creek adjacent to Cone Ranch	33	1/25/2000
1482	Poor	SCI	BLCKWTER 4	Blackwater Creek adjacent to Cone Ranch	15	4/24/2000
1482	Poor	SCI	BLCKWTER 5	Blackwater Creek adjacent to Cone Ranch	19	8/29/2000
1482	Poor	SCI	BLCKWTER 4	Blackwater Creek adjacent to Cone Ranch	19	8/29/2000
1495B	Good	SCI	FLJUICEREF	ITCHEPACKESASSA Ck, ref site for Fla Juice FYI	23	4/29/1996
1495B	Good	SCI	ICHTP60TST	Itchepackasassa Ck @ CR 582	23	8/6/1996

1495B	Good	SCI	FLJUICETST	ITCHEPACKESASSA Ck, test site for Fla Juice FYI	21	4/29/1996
1495B	Good	SCI	FLJUICEREF	ITCHEPACKESASSA Ck, ref site for Fla Juice FYI	21	11/6/1995
1495B	Suspect	BIORECON	ICHTP60TST	Itchepackasassa Ck @ CR 582	2	10/25/2002
1495B	Poor	SCI	FLJUICETST	ITCHEPACKESASSA Ck, test site for Fla Juice FYI	19	11/6/1995
1495B	Suspect	BIORECON	IC10	Itchepackesassa Creek downstream of Kraft Rd bri	1	2/7/2002
1495B	Healthy	BIORECON	ICHTP60TST	Itchepackasassa Ck @ CR 582	3	1/31/2002

Next the chemical water quality data is summarized. Tables showing the water quality monitoring stations in each WBID and a summary of the water quality results are shown below.

Table 2: Water Quality Observation Stations used in assessment for Blackwater Creek, WBID 1482

Station number	Station Name	First	Last Date
21FLKWATHIL-BLREEK150-2	hillsborough-blackwater creek-150-2	1/25/2000	11/26/2002
112WRD 280828082062900		7/24/2001	9/4/2001
112WRD 280858082124800		5/8/2001	9/4/2001
21FLGW 7442	swb-hs-1062	5/23/2000	5/23/2000
21FLHILL143	blackwater creek at sr 39 under rr bridge	1/19/1999	12/10/2002
21FLHILL24030003	blackwater cr at sr 39 under rr bridge	1/22/1991	12/8/1998
21FLKWATHIL-BLREEK114-1	hillsborough-blackwater creek-114-1	5/20/2000	5/20/2000
21FLKWATHIL-BLREEK114-2	hillsborough-blackwater creek-114-2	5/20/2000	5/20/2000
112WRD 02302500	blackwater creek nr knights, fla.	1/16/1991	9/12/2001
21FLKWATHIL-BLREEK150-1	hillsborough-blackwater creek-150-1	1/25/2000	11/26/2002
21FLTPA 24030100	cr5 - blackwater creek	9/27/1999	8/29/2000
21FLKWATHIL-BLREEK150-3	hillsborough-blackwater creek-150-3	1/25/2000	11/26/2002
21FLPOLKBLACKWATERCR1	blkwtr cr @ n harrelson r	6/14/1994	11/5/1998
21FLPOLKBLACKWATERCR2	blackwater creek2	11/4/2003	11/12/2003
21FLSWFDFLO 51 2513 0	blackwater creek @ shady oak dr.	12/10/2002	12/10/2002
21FLSWFDFLO 51 2515 0	blackwater creek @ sr 39	12/10/2002	12/10/2002
21FLSWFDFLO0011	hills r - black wtr ck ab itchepackasassa ck	3/23/1992	8/24/1993
21FLSWFDFLO0013	hills r - e canal ab itchepackasassa ck- grif rd	12/10/1992	12/10/1992
21FLTPA 24030097	cr4 - blackwater creek	9/27/1999	8/29/2000
21FLKWATHIL-BLREEK114-3	hillsborough-blackwater creek-114-3	5/20/2000	5/20/2000

Biochemical Oxygen Demand

BLACKWATER CREEK is on the 303(d) list for Biochemical Oxygen Demand and low DO. The water quality criteria for fresh waters states that the dissolved oxygen should not be less than 5.0 mg/L, and for water quality assessments the dissolved oxygen should not be less than 5.0 in more than 10% of the samples. Florida’s criterion states that BOD shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each Class and, in no case, shall it be great enough to produce nuisance conditions.

Table 3: Summary of data for BLACKWATER CREEK

Parameter	Obs	Max	Min	Mean	StDev	Violations	Florida Criteria
Dissolved Oxygen (mg/l)	163	12.40	1.30	6.27	1.56	29	5
BOD 5-Day (mg/l)	112	5.70	0.10	1.51	0.85	NA	none

Table 4: Summary of data for ITCHEPACKASASSA CREEK

Parameter	Obs	Max	Min	Mean	StDev	Violations	Florida Criteria
Dissolved Oxygen (mg/l)	57	9.98	0.56	4.87	2.27	29	5

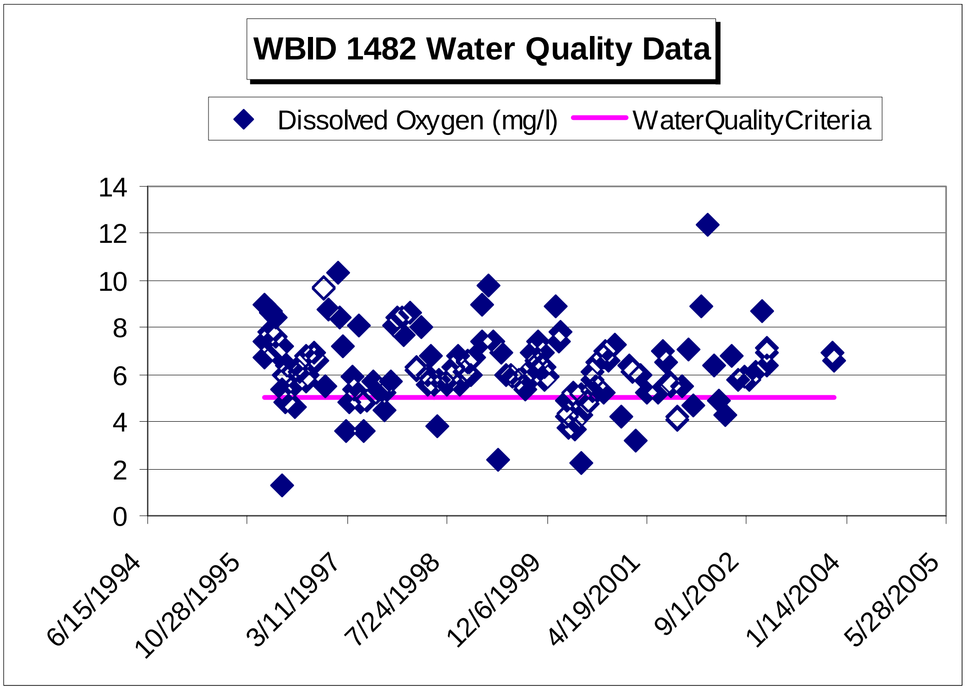


Figure 2: Dissolved Oxygen (DO) data. Median DO is 6.1mg/l.

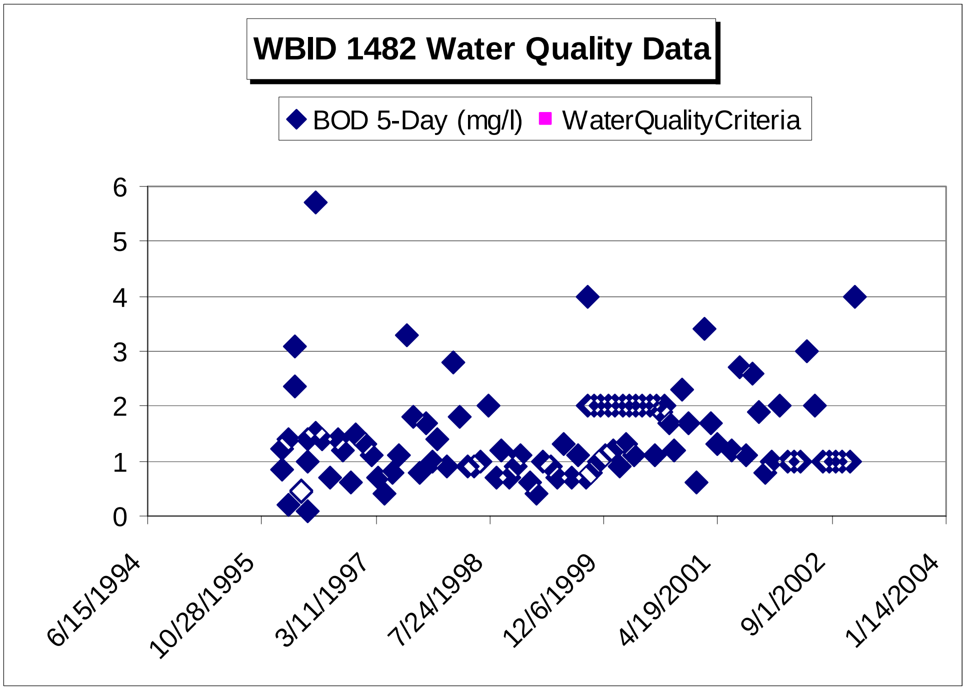


Figure 3: Biochemical Oxygen Demand (BOD) data. Median BOD is 1.3 mg/l and the statewide average is 1.4.

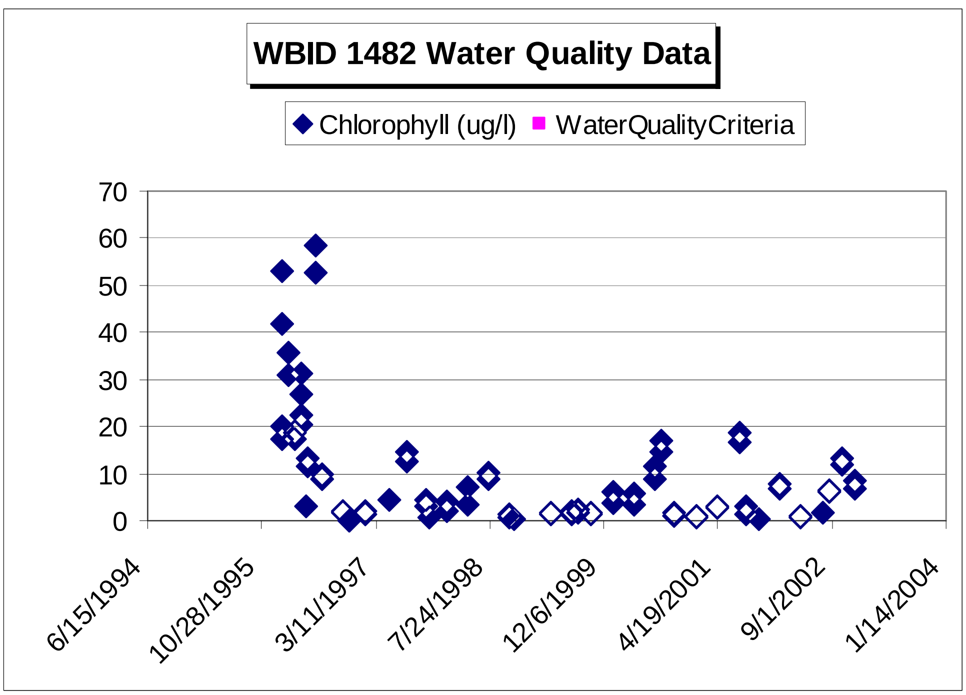


Figure 4: Chlorophyll-a data. Median chlorophyll-a is 4.38 ug/l and the statewide median ranges from 3 to 4.

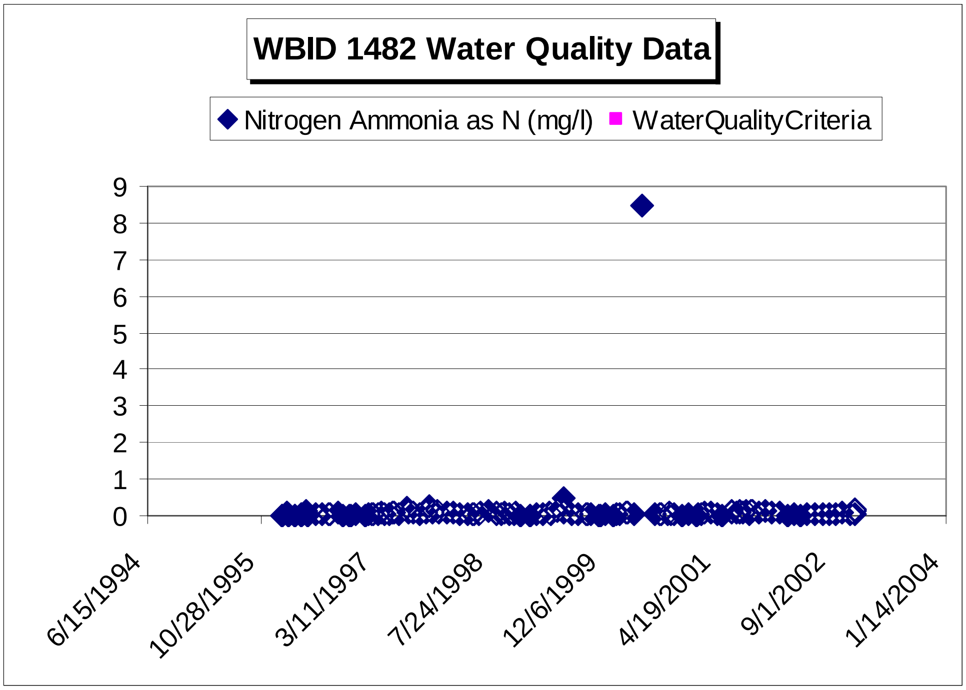


Figure 5: Ammonia data from Blackwater Creek has a median of 0.05 mg/l and the statewide median is 0.036 mg/l.

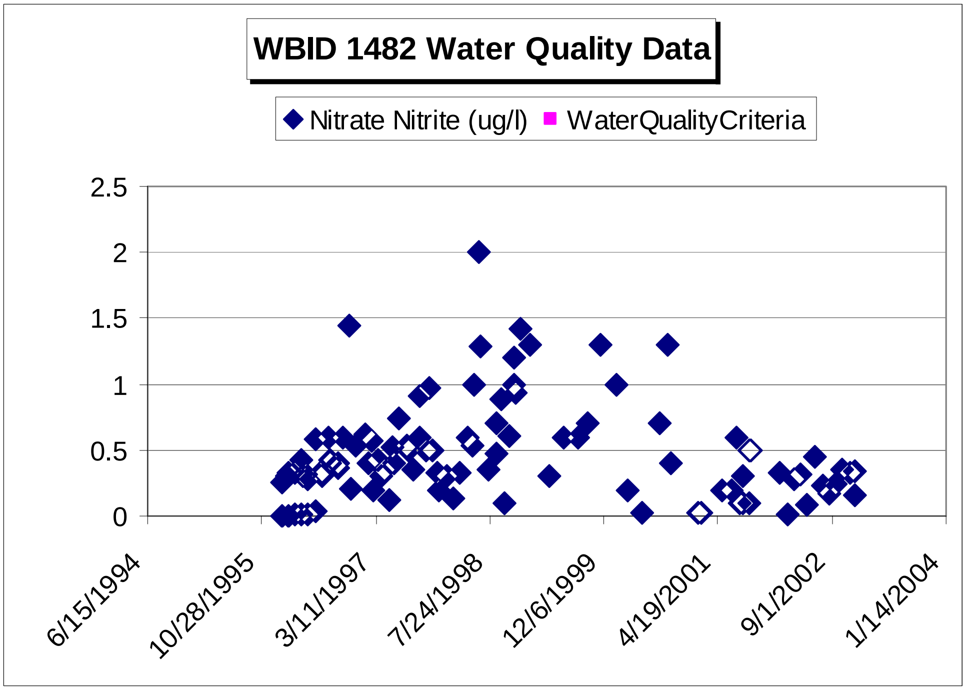


Figure 6: Nitrate plus nitrite data from Blackwater Creek has a median of 0.358 mg/l and the statewide median is 0.069. Note: Chart data is in mg/l not ug/l.

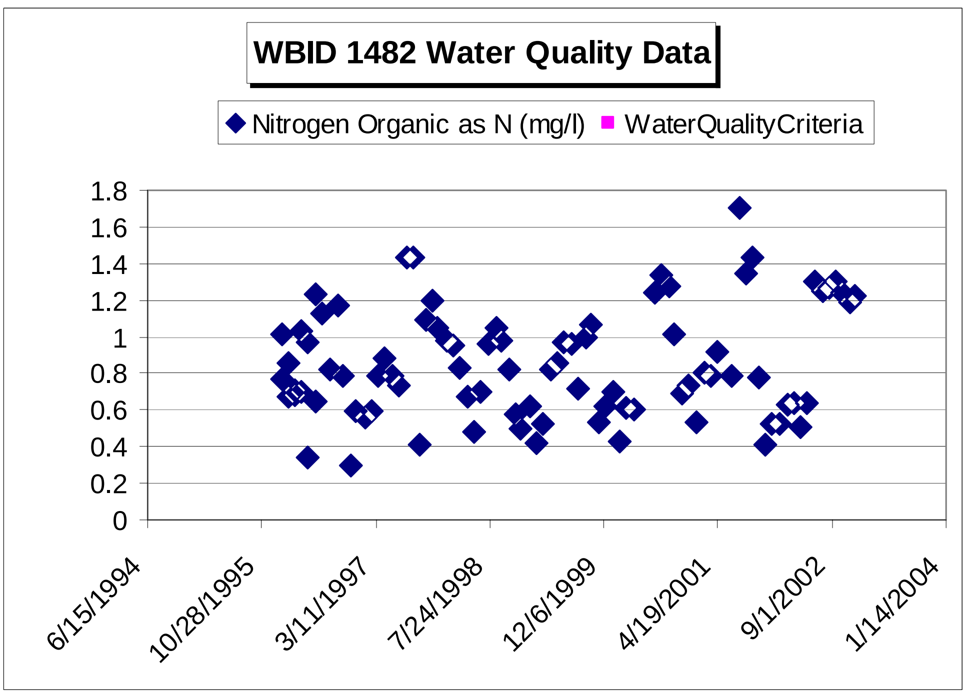


Figure 7: Median organic nitrogen in Organic nitrogen data from Blackwater Creek has median of 0.79 ug/l and the statewide median is 0.84.

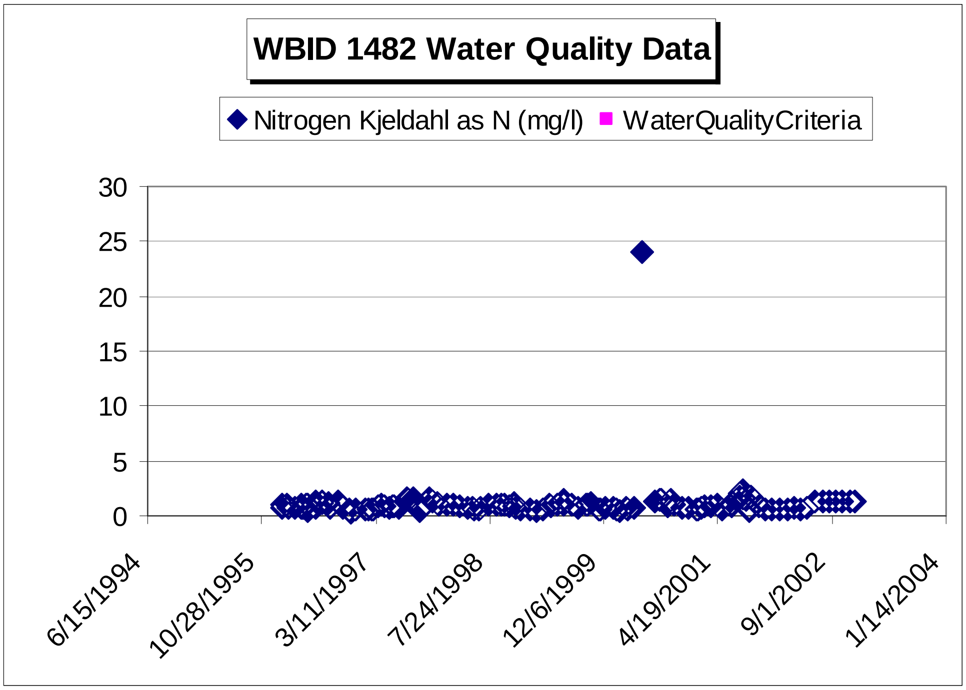


Figure 8: Median TKN is 0.86 mg/l and the statewide median is 1.1.

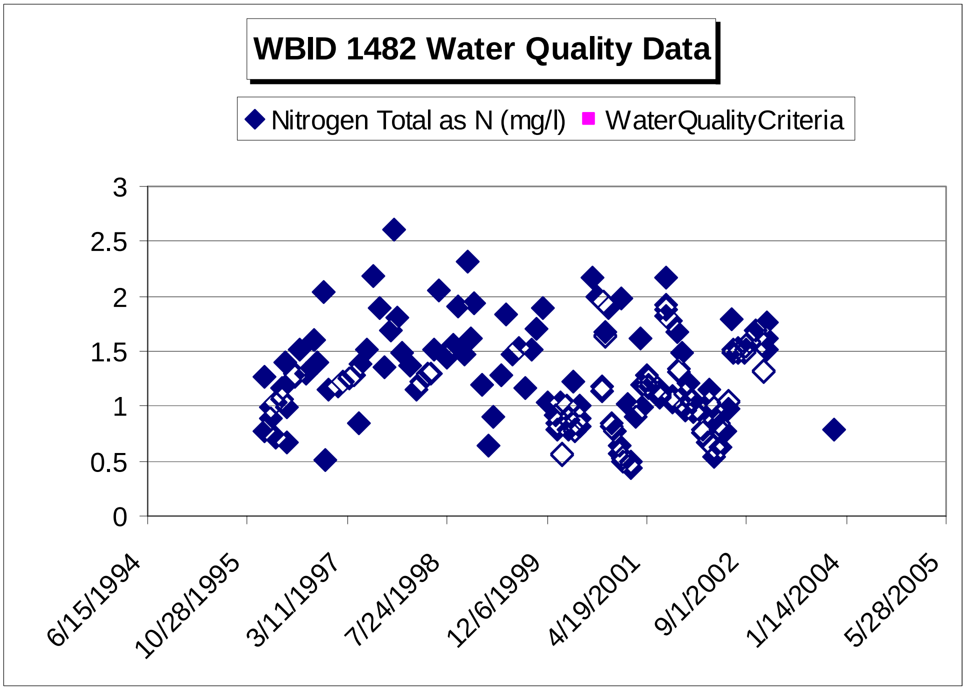


Figure 9: Median total nitrogen is 1.17 mg/l and the statewide median is 1.2.

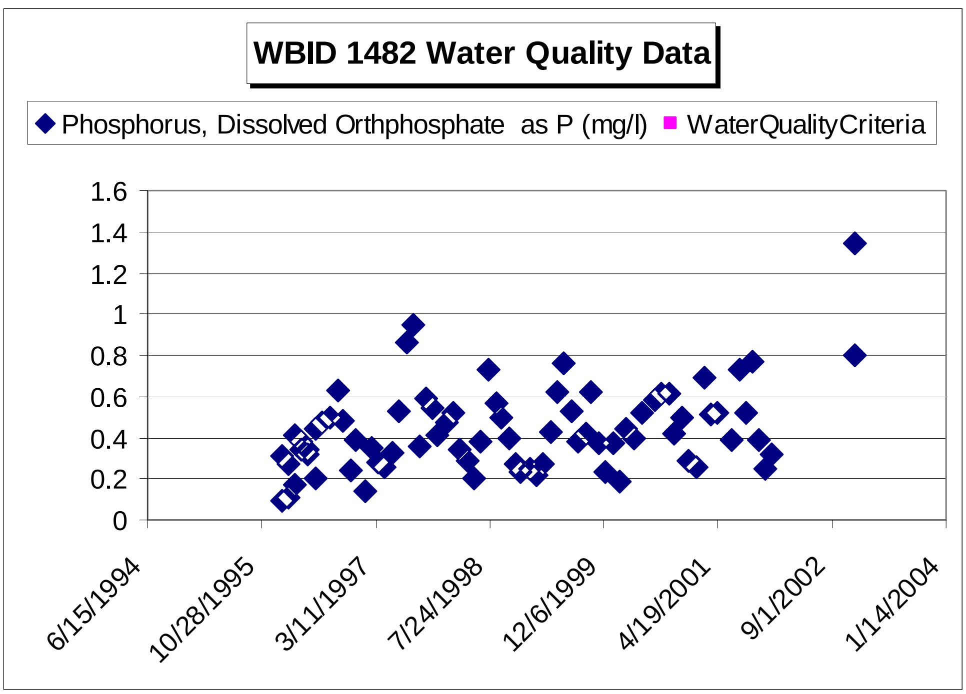


Figure 10: Median dissolved orthophosphate is 0.4 mg/l and the statewide median is 0.045.

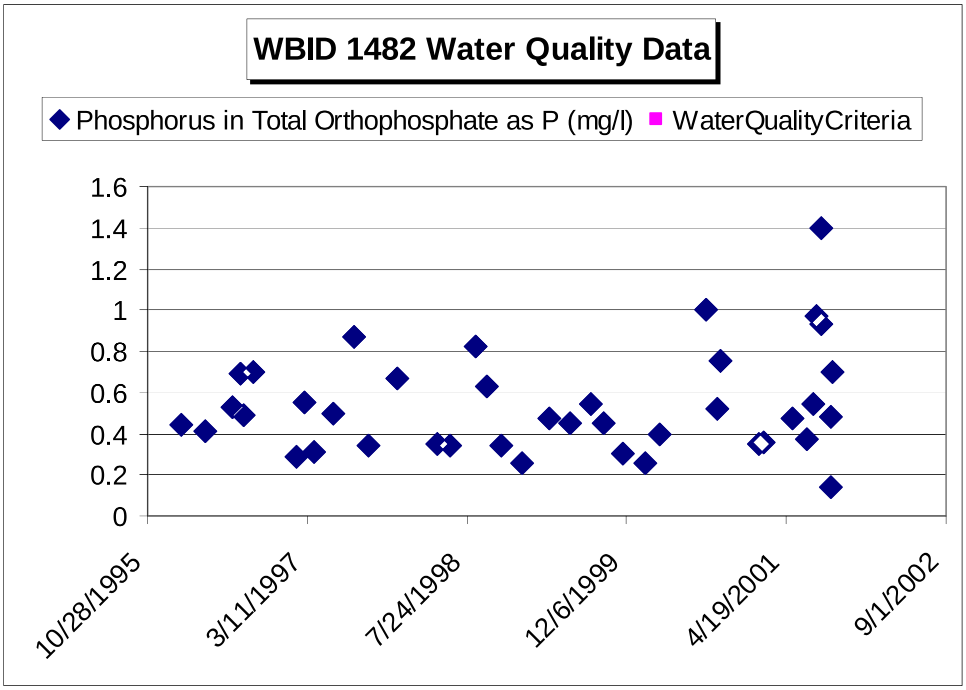


Figure 11: Median total orthophosphate is 0.475 mg/l and the statewide median is 0.03.

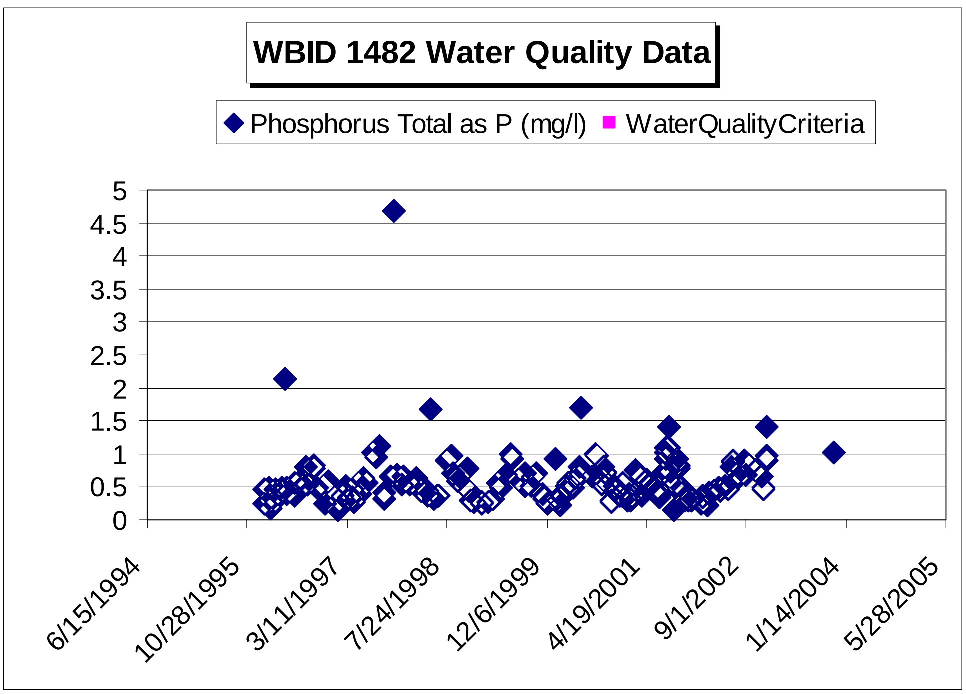


Figure 12: Median total phosphorus is 0.521 mg/l and the statewide median is 0.075.

Dissolved oxygen (DO) ranges from 1.3 to 12.4 mg/l. Twenty-nine of 163 (18%) DO samples were below the criterion of 5 mg/l. As an indication of imbalance of natural flora or fauna, FDEP's IWR states a maximum annual mean value of chlorophyll-a should not exceed 20 ug/l or annual mean chlorophyll-a values should not have increased by more than 50% over historical values for at least two consecutive years. Blackwater Creek data show chlorophyll-a has been below 20 in all samples taken since 1996 when levels were measured up to 60 ug/l.

BOD in Blackwater Creek ranges from 0.1 to 5.7 with a median value of 1.3 and the statewide average is 1.4.

Median total phosphorus and total nitrogen is 0.521 and 1.17 mg/l, respectively. This gives a nitrogen to phosphorus ratio of about 2, which results in a nitrogen limitation and excess phosphorus in the water. Calculating similarly with the portions of phosphorus and nitrogen readily available to plant uptake, the ratio is 0.05 ammonia to 0.4 dissolved orthophosphate. This gives a ratio of about 0.125 which confirms the nitrogen limitation.

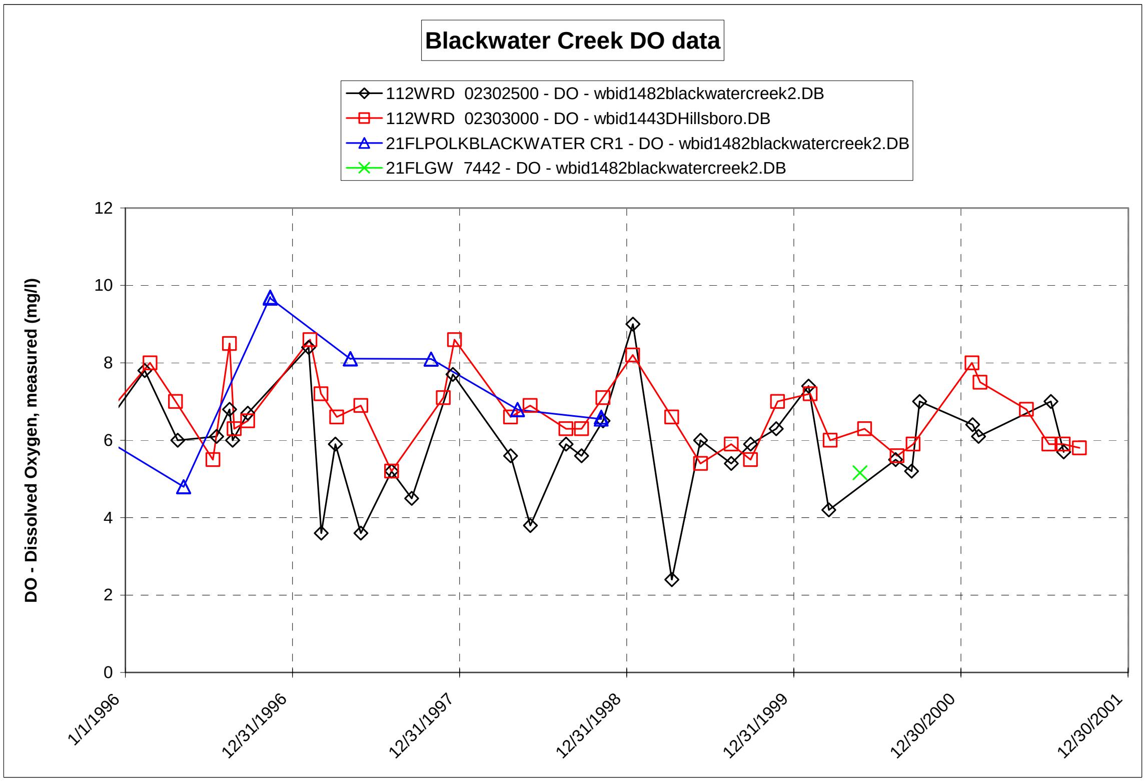
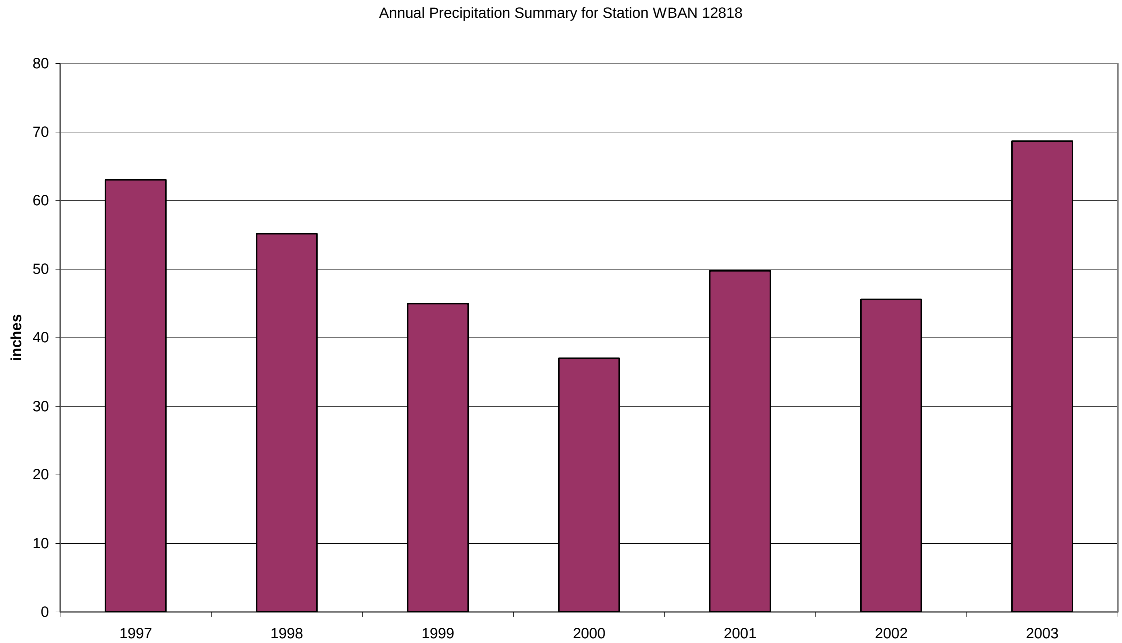


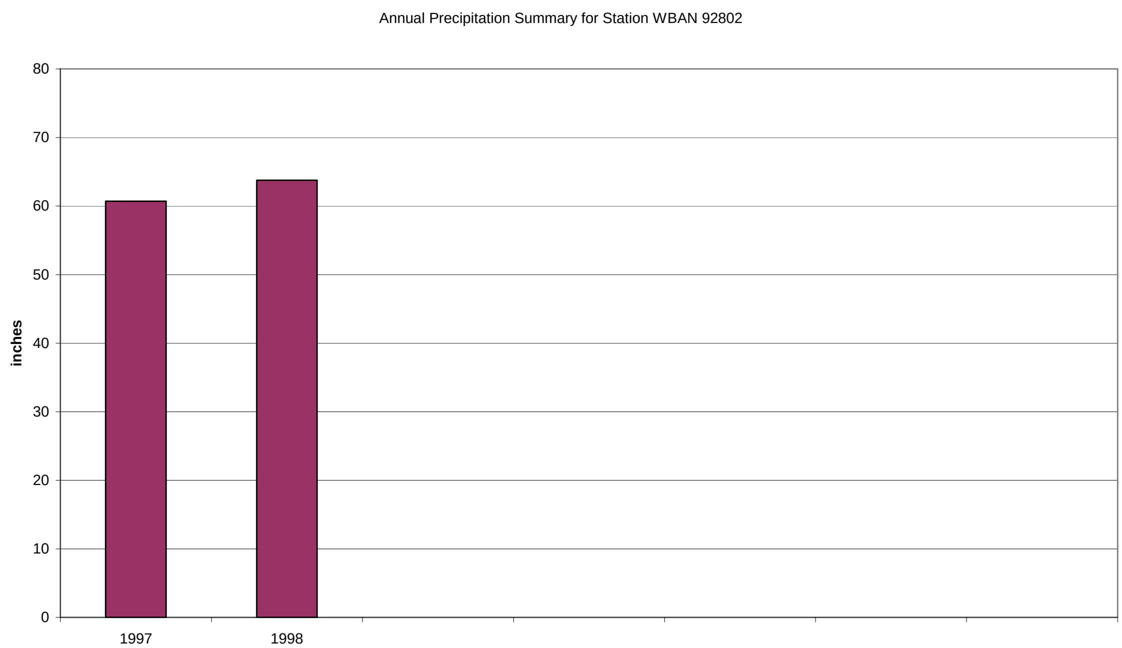
Figure 13: DO data at several stations in Blackwater Creek

Figure 13 shows the DO is near or above the standard at stations 21FLGW7442 and 21FLPOLKBLACKWATERCR1 which are upstream of the confluence with Itchepackasassa Creek. The DO is frequently below the standard at station 112WRD02302500 which is below the confluence with Itchepackasassa Creek. The DO improves farther downstream at station 112WRD02303000 in the Hillsborough River.

Precipitation Data

NCDC meteorological stations in the Hillsborough River Basin include two WBAN stations and three COOP stations. These are WBAN 12818 Brooksville, WBAN 92802 Newport Ritchie, COOP 083986 Hillsborough River State Park, COOP 088783 Tampa Fowler Ave., and COOP 087205 Plant City. Annual summaries of the precipitation recorded at these stations shows wet and dry periods in the years from 1997 to 2003.





SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of sources or source categories in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities including certain urban stormwater discharges such as municipal separate storm sewer systems (MS4 areas), certain industrial facilities, and construction sites over one acre are storm water driven sources that are considered as "point sources" in this report.

Non-point sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance. These include nutrient runoff of agricultural fields and golf courses, septic tanks, and residential developments outside of MS4 areas.

WBID	Residential (FLUCCS 1100-1300)	Comm, Ind, public (FLUCCS 1400-1500,1700-1900)	Agriculture (FLUCCS 2100-2600)	Rangeland (FLUCCS 3100-3300)	Forest (FLUCCS 4100-4400)	Water (FLUCCS 5100-5400)	Wetlands (FLUCCS 6100-6500)	Barren &Extractive (FLUCCS 1600,7100-7400)	Transportation and Utilities (FLUCCS 8100-8300)	TOTAL
1482	1525.99	180.60	8569.83	1810.92	2144.85	76.65	4913.52	371.06	151.96	19745.39
1495B	1054.04	1038.08	2581.96	420.83	1692.29	144.55	1302.62	13.52	182.46	8430.34

Table 5: Landuse in acres

Nonpoint sources

Nonpoint sources that ultimately contribute to depletion of in-stream dissolved oxygen include sources of nutrients such as animal waste, waste-lagoon sludge ,fertilizer application to agricultural fields, lawns, and golf courses, and malfunctioning onsite sewage treatment and disposal systems or septic tank systems.

The State of Florida Department of Health (www.doh.state.fl.us/environment/statistics) publishes septic tanks data on a county basis. Table 6 summarizes the number of septic systems installed since the 1970 census and the total number of repair permits issued between 1996 and 2001. The data does not reflect septic tanks removed from service.

Table 6: County Estimates of Septic Tanks and Repair Permits (FDEP, 2001)

County	Number of Septic Tanks (2002)	Number of Repair Permits Issued (1996 – 2002)
Hillsborough	100,483	1,651

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5)(c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

Landuse in the impaired WBIDs is shown in Table 5. The spatial distribution and acreage of different land use categories were identified using the 1999 land use coverage (scale 1:40,000) contained in the FDEP's GIS library. This dataset was derived from Ifrarred Digital Orthophoto Quadrangle photo interpreatations using the Florida Land Use Classification Code System (FLUCCS). Land use categories in the watershed were aggregated using the FLUCCS Level 2 codes.

Point sources

There are six NPDES permitted continuous dischargers to the impaired waters addressed by EPA developed TMDLs in the Tampa Bay tributaries basin.

Table 7: NPDES Facilities discharging to Impaired Waters

NPDES	Facility	Receiving Waters
FL0026557	Plant City WRF(D001)	Westside Canal to Pemberton Creek to Hillsborough River (prior to 1997)
FL0026557	Plant City WRF(D002)	Blackwater Creek (after 1997)
FL0032581	CSX Transportation, Inc.	Winston Creek to Itchepackessassa Creek

Also, there are municipal separate storm sewer systems (MS4) throughout the Hillsborough River Basin since the area is extensively developed. The MS4 areas by WBID1482 are Kathleen, Lakeland, and Winston.

ANALYTICAL APPROACH/ MODEL SELECTION AND DEVELOPMENT

Since this WBID was impaired for low DO, a water quality simulation model of the complex DO processes was utilized to analyze and develop a TMDL. Only seasonal trends of DO were simulated since DO violations of the standard were observed in the monthly trend monitoring data. The purpose of utilizing water quality models for the development of DO and BOD TMDLs in this stream system is to understand the linkage between the low in-stream DO and the factors that cause the low DO. The models can help determine which factors cause a greater effect than others. Some of the major factors in DO processes include watershed and stream flow and geometry, nutrient loads from the watershed, BOD loads from the watershed, in-stream plants and algae, and sediment oxygen demand.

The approach here is to model the Hillsborough River watershed hydrology, nutrient loads, BOD loads, then deliver these flows and loads to the impaired receiving streams, and finally model the in-stream water quality processes within these receiving streams. The major unknowns are the DO concentrations of the water flowing from the watershed into the receiving streams, and the BOD decay rates.

Due to the major unknown factors and the limited data, this model application is not intended to predict absolute DO values, but instead to predict the relative effect of nutrients, algae, and BOD on in-stream DO.

Mechanistic Model Approach

WAM was utilized to simulate the watershed hydrology and water quality loads for most of the Hillsborough River Basin. WASP models were set up to examine the DO processes in the Hillsborough River mainstem and the major tributaries Blackwater Creek, Itchepackesassa Creek, Baker Creek, New River, and Cypress Creek. The WAM model was used to predict flows and loads that were then linked to the WASP models.

The following summary on of the WAM model is from EPA's Watershed and Water Quality Modeling Technical Support Center web site (http://www.epa.gov/athens/wwqtsc/WAMView.pdf). WAM's interface uses ESRI's ArcView 3.2a with Spatial Analyst 1.1 (or 2.0). WAM was developed to allow engineers and planners to assess the water quality of both surface water and groundwater based on land use, soils, climate, and other factors. The model simulates the primary physical processes important for watershed hydrologic and pollutant transport. The WAM GIS-based coverages include land use, soils, topography, hydrography, basin and sub-basin boundaries, point sources and service area coverages, climate data, and land use and soils description files. The coverages are used to develop data that can be used in the simulation of a variety of physical and chemical processes.

WAM was developed based on a grid cell representation of the watershed. The grid cell representation allows for the identification of surface and groundwater flow and phosphorus concentrations for each cell. The model then "routes" the surface water and groundwater flows from the cells to assess the flow and phosphorus levels throughout the watershed. The model simulates the following elements: surface water and ground water flow allowing for the assessment of flow and pollutant loading for a tributary reach at both the daily and hourly time increment as necessary; water quality including particulate and soluble phosphorus, particulate and soluble nitrogen (NO3, NH4, and organic N), total suspended solids, and biological oxygen demand.

WAM was linked to WASP (SWET, 2003), which enables the simulation of dissolved oxygen and chlorophyll-a. The WAM model simulates the hydrology of the watershed using other imbedded models including "Groundwater Loading Effects of Agricultural Management Systems" (GLEAMS; Knisel, 1993), "Everglades Agricultural Area Model" (EAAMod; Botcher et al., 1998; SWET, 1999), and two submodels written specifically for WAM to handle wetland and urban landscapes. Dynamic routing of flows is accomplished through the use of an algorithm that uses a Manning's flow equation based technique (Jacobson et al., 1998). Attenuation is based on the flow rate, characteristics of the flow path, and the distance of travel. The model provides many features that improve its ability to simulate the physical features in the generation of flows and loadings including:

- Flow structures simulation
- Generation of typical farms
- BMPs
- Rain zones built into unique cells
definitions, which also allows use
with NEXRAD Data
- Full erosion/deposition and in-stream routing –is used with ponds and reservoirs
- Closed basins and depressions are simulated
- Separate simulation of vegetative areas in residential and urban
- Simulation of point sources with service areas
- Urban retention ponds
- Impervious sediment buildup/washoff
- Shoreline reaches for more precise delivery to rivers, lakes, and estuaries

• Wildlife diversity within wetlands
• Spatial map of areas having wetland assimilation protection
• Indexing submodels for BOD, bacteria, and toxins
The overall operation of the model is managed by the ArcView-based interface. The interface allows the user to view available data, modify land use conditions, execute the model, and view results.

In order to evaluate the effect of BOD, nutrients, algae, and other oxygen demanding substances on DO processes a Water Quality Analysis Simulation Program (WASP) model was setup for this river segment. The Water Quality Analysis Simulation Program version 6 (WASP6) is an enhancement of the original WASP (Di Toro et al., 1983; Connolly and Winfield, 1984; Ambrose, R.B. et al., 1988). This model helps users interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. WASP6 is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the basic program. Water quality processes are represented in special kinetic subroutines that are either chosen from a library or written by the user. WASP is structured to permit easy substitution of kinetic subroutines into the overall package to form problem-specific models. WASP6 comes with two such models -- TOXI for toxicants and EUTRO for conventional water quality. Earlier versions of WASP have been used to examine eutrophication of Tampa Bay; phosphorus loading to Lake Okeechobee; eutrophication of the Neuse River and estuary; eutrophication and PCB pollution of the Great Lakes (Thomann, 1975; Thomann et al., 1976; Thomann et al, 1979; Di Toro and Connolly, 1980), eutrophication of the Potomac Estuary (Thomann and Fitzpatrick, 1982), kepone pollution of the James River Estuary (O'Connor et al., 1983), volatile organic pollution of the Delaware Estuary (Ambrose, 1987), and heavy metal pollution of the Deep River, North Carolina (JRB, 1984). In addition to these, numerous applications are listed in Di Toro et al., 1983.

The flexibility afforded by the Water Quality Analysis Simulation Program is unique. WASP6 permits the modeler to structure one, two, and three-dimensional models; allows the specification of time-variable exchange coefficients, advective flows, waste loads and water quality boundary conditions. The eutrophication module of WASP6 was applied to the Blackwater Creek in this study.

Flow, depth, velocity, and nutrient and BOD loads predicted by the WAM model was used in the WASP models. Solar radiation data was obtained on the University of Florida Institute of Food and Agricultural Sciences, Florida Automated Weather Network world-wide-web site http://fawn.ifas.ufl.edu/. Sediment oxygen demand (SOD) can be a major contributor to low D.O. SOD measurements in the nearby Alafai River range from 1.2 to over 7 grams/square meter/day, (Measured Sediment Oxygen Demand Rates, USEPA). SOD measurements in the Ocklawaha River Basin's Rice Creek upstream of the Georgia Pacific Mill discharge range from 1.5 to 3.0. SOD rate of 1.5 was used in this WASP model for Blackwater Creek. Incremental BOD and nutrient loads were entered into WASP from the results of the WAM model. These estimated existing nutrient and BOD loads from the watershed are summarized in Table 8. In-stream model predictions compared to observed water quality data are shown next.

Table 8: Model predicted nitrogen, phosphorous and biochemical oxygen demand loads

Year	TN (kg/d)	TP (kg/d)	BOD (kg/d)	Annual Average Flow (m3/s)
1999	128	31	226	1.52
2000	159	50	283	1.77
2001	259	75	554	2.81
2002	218	51	353	2.39
2003	264	61	442	3.34

Table 9: Point source permitted loads

Point Source Facilities	TN (kg/d)	TP (kg/d)	$CBOD_5$ (kg/d)	Flow (m3/s)
Plant City, FL0026557	30.4	10.1	50.7	0.12

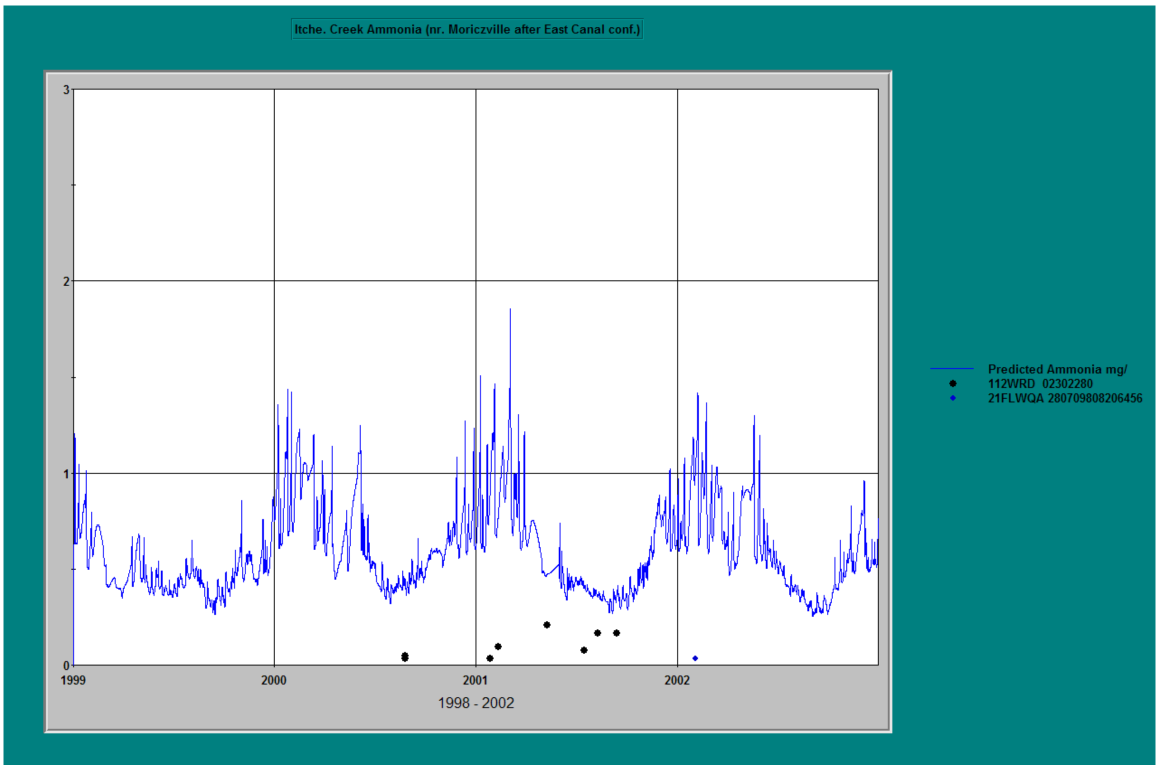


Figure 14: Itchepackesassa Creek observed and predicted ammonia

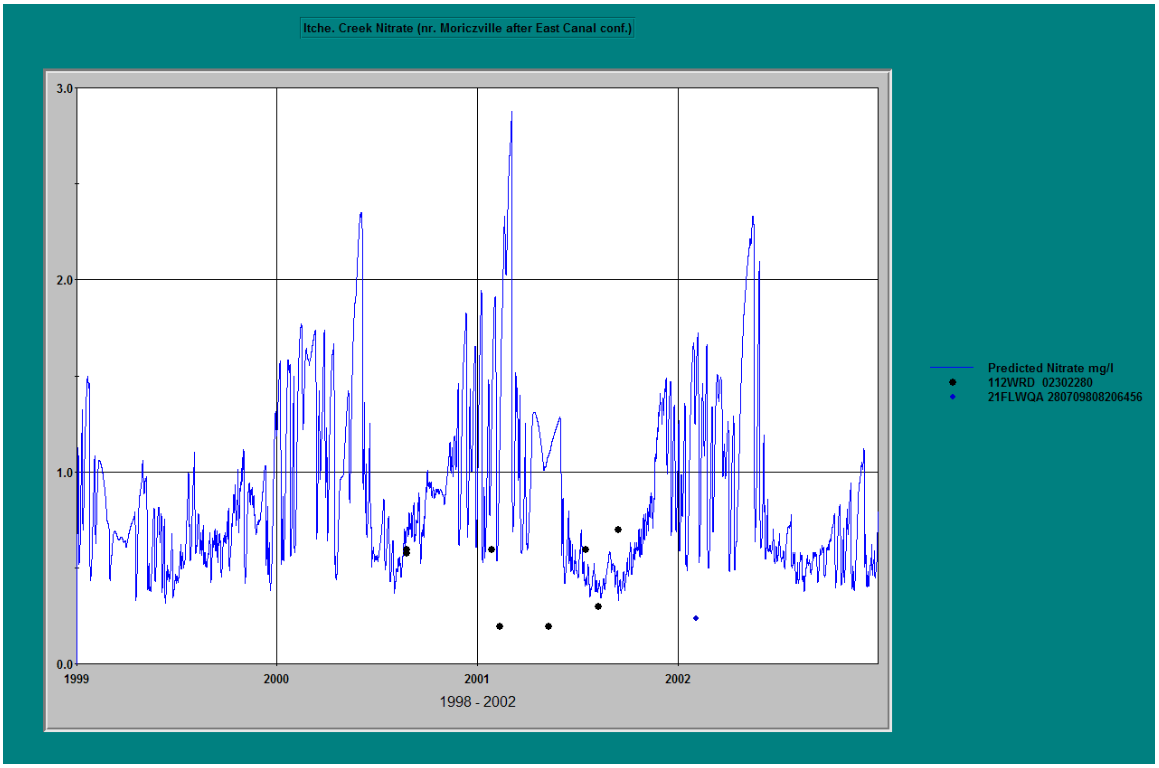


Figure 15: Itchepackesassa Creek observed and predicted nitrate

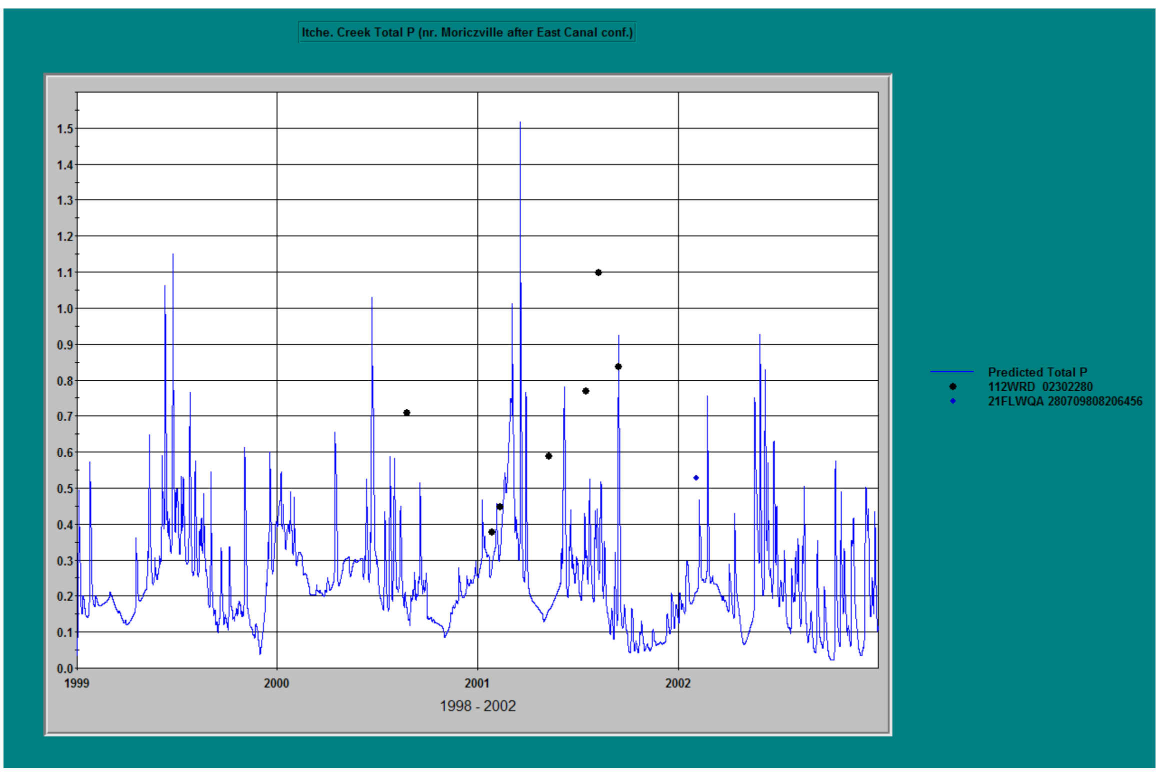


Figure 16: Itchepackesassa Creek observed and predicted phosphorous

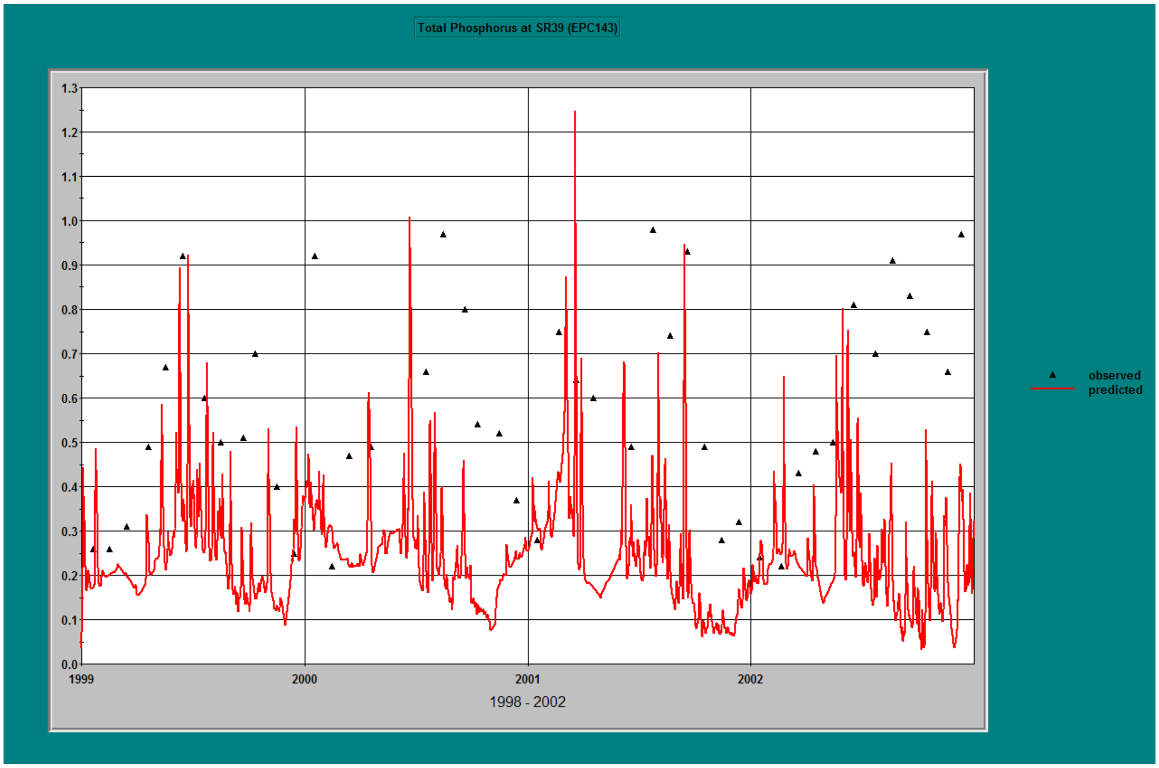


Figure 17: Blackwater Creek observed and predicted phosphorous

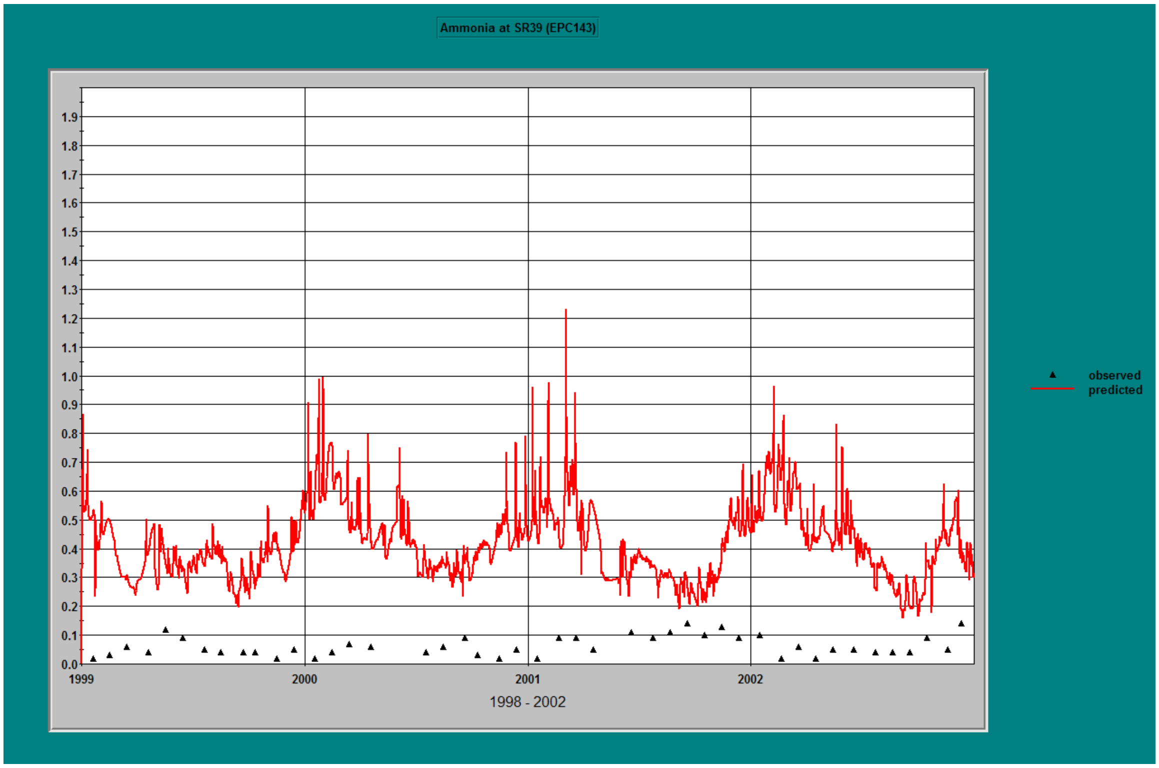


Figure 18: Blackwater Creek observed and predicted ammonia

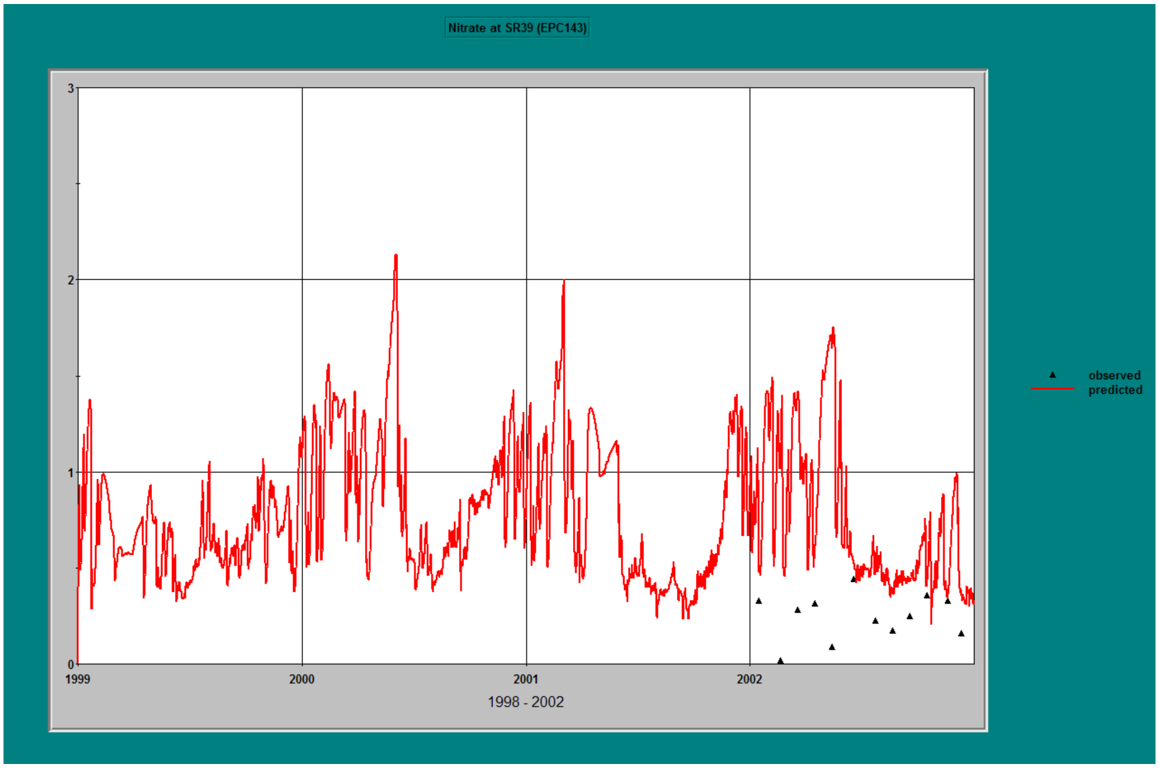


Figure 19: Blackwater Creek observed and predicted nitrate

The TMDLs were developed by using the model to understand the river system and determine the levels of the water quality parameters that result in attainment of the DO water quality standard.

As shown in Figure 3 and again in Figure 22, BOD is relatively low, near detection limits and has little impact on the DO in this river system. Figure 20 and Figure 21 show that the DO varies little with a three fold difference in BOD.
Nutrients can affect the DO through algae production and respiration. An excess of algae growth can imbalance the natural system and cause large DO swings from high supersaturation to low levels. Additionally, the algae population can reach a limiting level of nutrients or light and then experience a large die-off, that can then result in DO consumption and low in-stream DO. Figure 23 shows that DO in this river system is not greatly affected by algae production. Excess growth of algae may be partially prevented by the naturally dark water in this system.

Sediment oxygen demand (SOD) is another factor that can contribute to low DO. However, based on measured data from similar streams and the model results, the SOD in the stream channel is likely not high enough to cause the chronic low DO found in this river system.

After examining each of the factors that can contribute to low DO, the levels of these factors found in the Itchepackesassa Creek and Blackwater Creek system are not excessive enough to cause the chronically low DO found in this system.
The low DO in this river system is likely a result of natural processes in the wetlands and groundwater flowing into these streams. Since the watershed model is not simulating the DO processes on the watershed and wetland areas, and the receiving stream model is simulating only the processes that occur in the streams, the DO levels in the water flowing from the wetlands and groundwater to the streams is unknown. The sensitivity of the in-stream DO to the DO concentration of the water entering from the watershed can be simulated by ranging these watershed DO concentrations. Figure 24 (Itchepackesassa Creek) and Figure 25 (Blackwater Creek) show simulated in-stream DO with the watershed DO set to 2 mg/l and then at 5 mg/l. This demonstrates that if the water flowing from the watershed had DO concentrations of 5 mg/l then the in-stream DO would remain above the water quality standard. Note that the few days in June 2000 and Sept. 2001 during which the DO drops slightly below 5 mg/l are due to model upsets and are ignored.

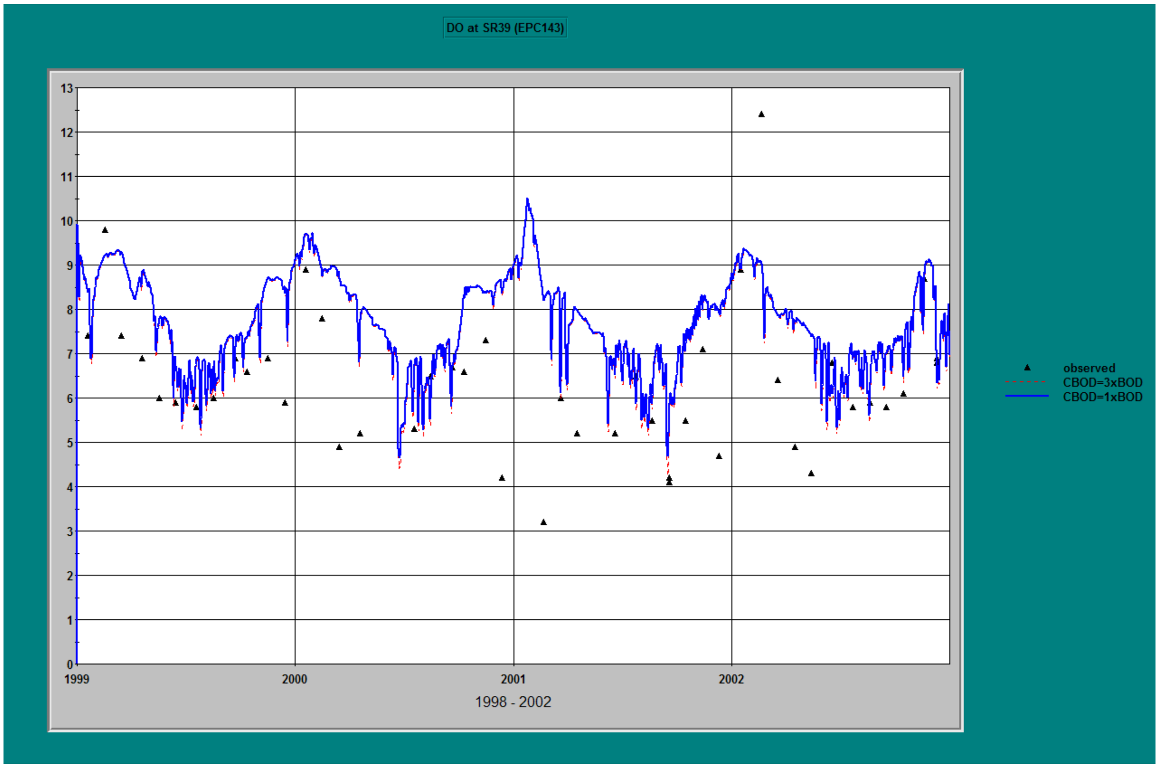


Figure 20: Blackwater Creek in-stream DO with in-stream CBOD at 1xBOD5 and 3xBOD5

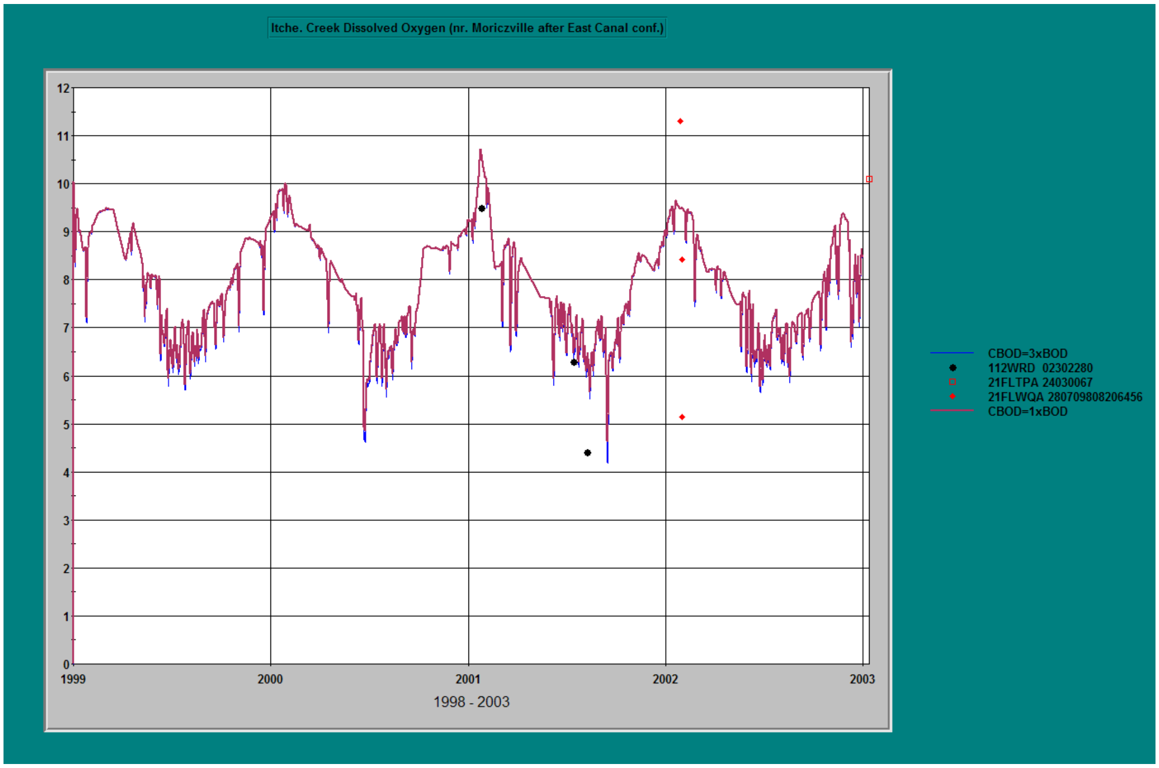


Figure 21: In-stream DO with in-stream CBOD at 1xBOD5 and 3xBOD5

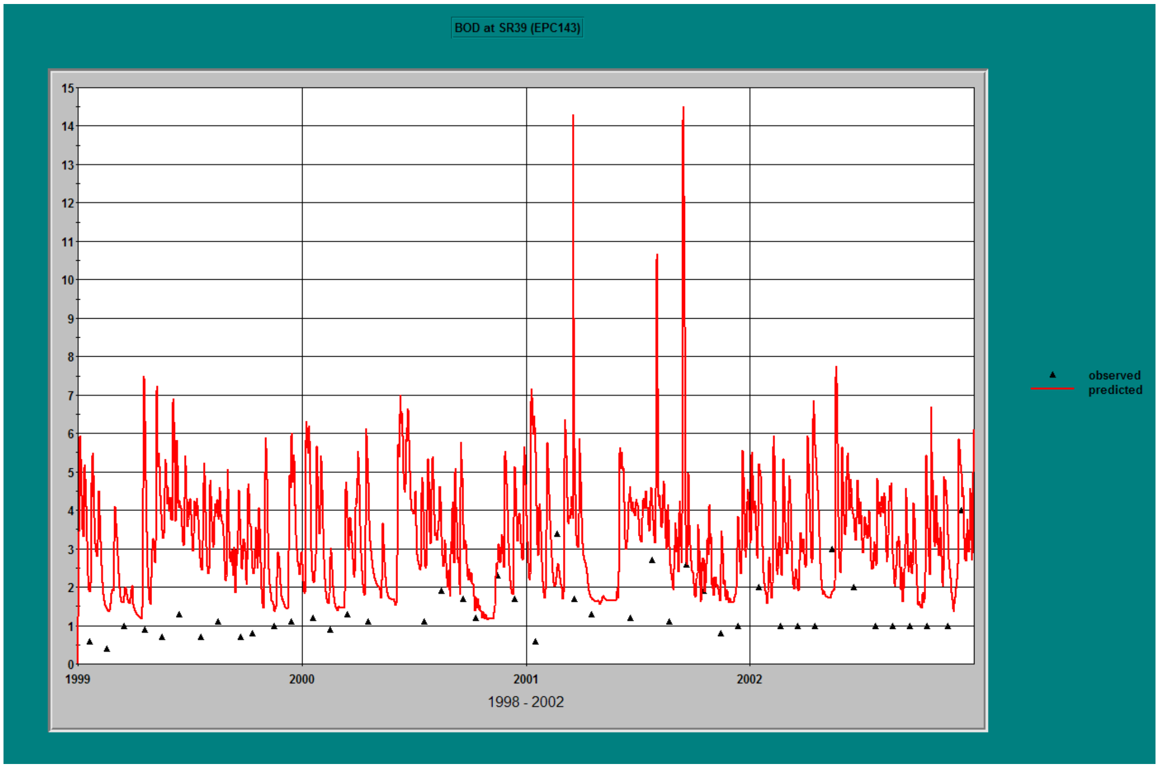


Figure 22: Blackwater Creek predicted CBODu and observed BOD5

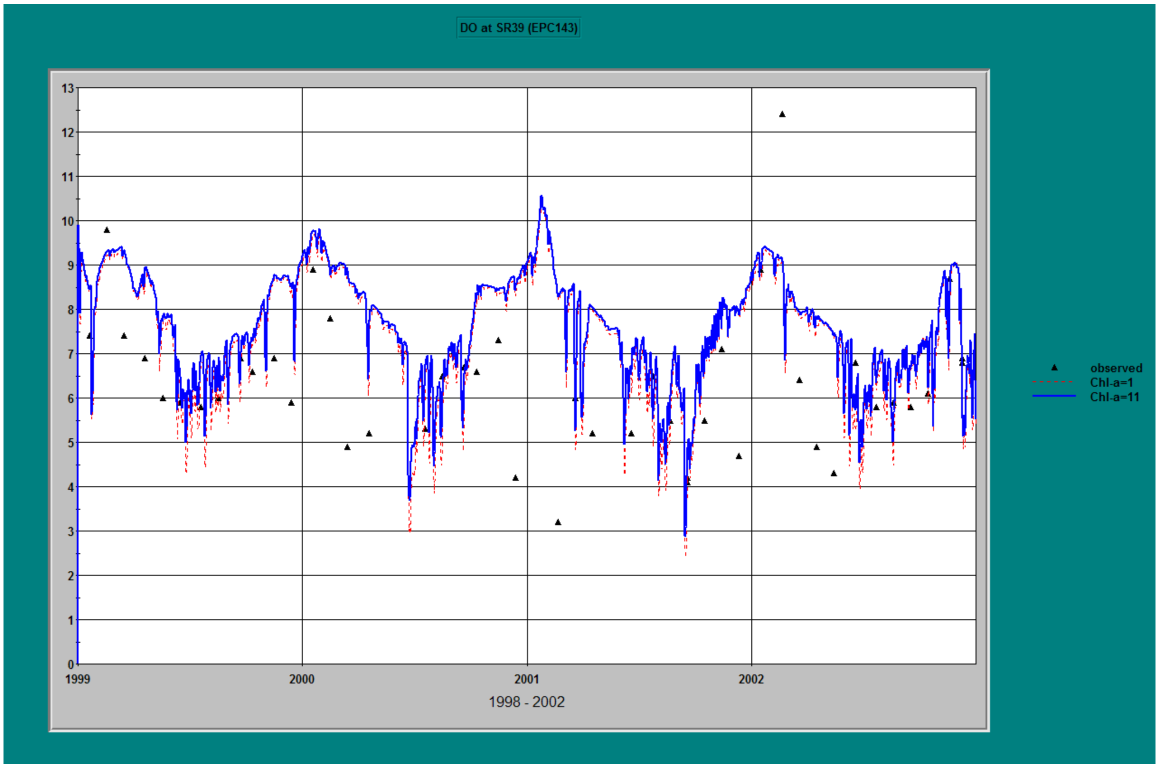


Figure 23: Blackwater Creek DO with Chlorophyll at 1 ug/l and 11 ug/l

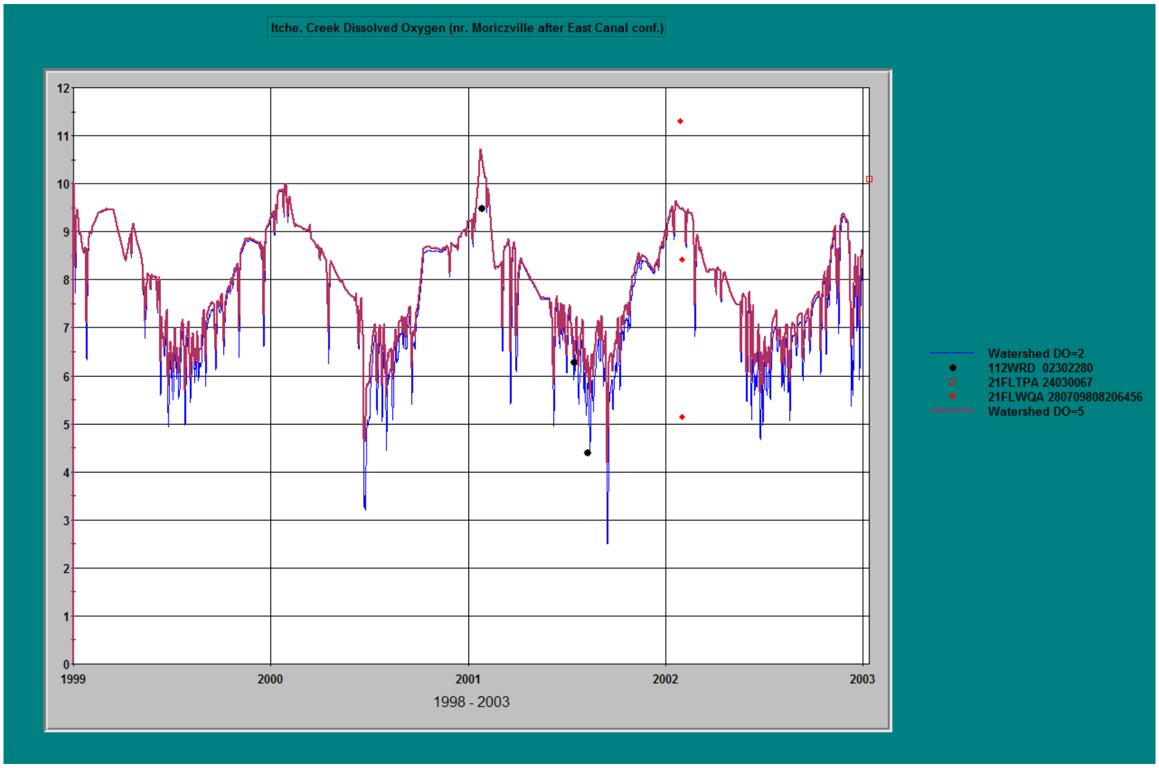


Figure 24: Instream DO with watershed DO concentration at 2 and 5 mg/l

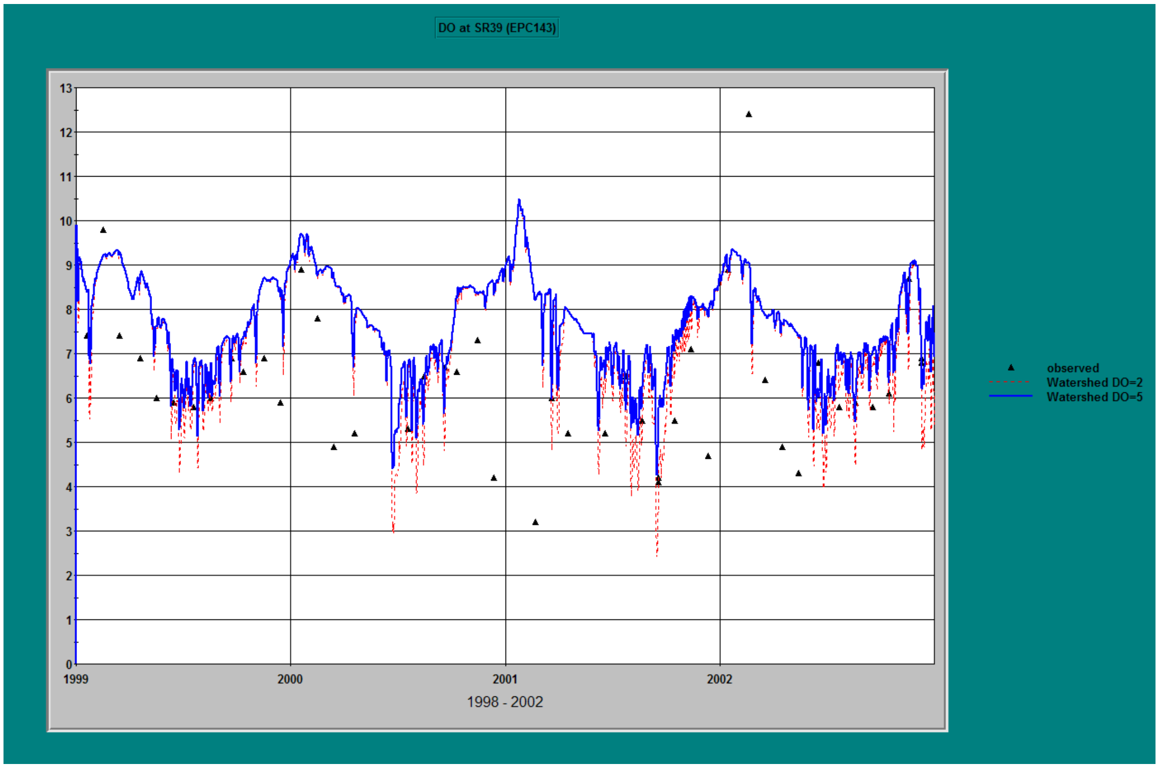


Figure 25: Blackwater Creek Instream DO with watershed DO concentration at 2 and 5 mg/l

ALLOCATIONS

The TMDL and allocation of the load is shown in Table 10. Since the low in-stream DO is a result of low DO water flowing from groundwater and wetlands, and not the result of in-stream algae, nutrient, and BOD oxygen consumption, no load reductions are specified in this TMDL report. It is recommended that loads of nutrients and BOD be maintained at current levels. The TMDL for DO 1204 kg/d, the amount of dissolved oxygen in the Creek at 2.81 cubic meters per second median annual average flow, to achieve the water quality standard of 5 mg/l. The TMDL for BOD it is the current estimated annual average load of 554 kg/d. We recommend that a site-specific DO criteria be developed for Blackwater Creek to account for the influence of natural low dissolved oxygen in ground water and surrounding wetlands under low flow conditions. Assuming the mean wetland and ground water dissolved oxygen concentration is 2.0 mg/l, 720 kg/d of dissolved oxygen would have to be added to the system to achieve the DO water quality criteria of 5.0 mg/l.

Table 10: TMDL load allocations to Blackwater Creek

Pollutant	TMDL	WLA		LA	MOS
		Continuous	MS4		
Dissolved Oxygen (DO)	5.0 mg/l or 1204 kg/d	53 kg/d	0.0	1151 kg/d	implicit
Biochemical Oxygen Demand	554 kg/d	52.2 kg/d	0.0	452 kg/d	50 kg/d

Waste Load Allocations (Regulated with treatment plant and stormwater permits)

The waste load allocation (WLA) is divided into continuous discharges from treatment plants and storm water loads from municipal separate storm sewer systems. The continuous WLA for DO is equal to the water quality standard of a minimum of 5 mg/l. For 5-day carbonaceous biochemical oxygen demand the continuous WLA is a maximum of 52.2 kg/d which is based on the current permit limits of 5 mg/l. The regulated storm-water loads should also be held at current levels which is specified as zero percent reduction of BOD and zero change in DO.

Load Allocations (Non- Regulated)

The LA for DO is equal to the water quality standard of a minimum of 5 mg/l. For 5-day carbonaceous biochemical oxygen demand the LA is a maximum of 452 kg/d which is based on the estimated watershed loads less a ten percent margin of safety.

MARGIN OF SAFETY

A ten percent explicit margin of safety is included in the allocation of BOD. This also implies an implicit margin of safety on the DO allocation.

CRITICAL CONDITIONS

Critical conditions were considered by analyzing a multi year period containing wet, normal, and dry conditions. Since these impaired waters receive both storm water driven loads and continuous flow loads, both wet events and dry events were analyzed.

SEASONAL VARIATION

Seasonal variation was considered by analyzing a multi year period containing all seasons and wet, normal, and dry conditions.

REFERENCES

Florida Department of Environmental Protection (DEP), Basin Status Report for the Tampa Bay Tributaries Basin, DEP Division of Water Resource Management, Central District, Group 2 Basin, March 2003.

Florida Administrative Code (F.A.C.). Chapter 62-302, Surface Water Quality Standards.

Hillsborough County Environmental Protection Commission. Surface Water Quality 1996 – 2000 Hillsborough County, Florida.

National Agricultural Statistics Service (NASS), Agricultural Census for 1997, U.S. Department of Agricultural.

SWET. 2002. WAM Training Manual. Developed for EPA Region IV Training. Published by: Soil and Water Engineering Technology, Inc., Gainesville, FL.

USDA, 1997. 1997 Census of Agriculture, Volume 1, Geographic Area Series, Part 42, U.S. Department of Agriculture, National Agricultural Statistics Service. AC97-A-42, March 1999.

USEPA, 1991. Guidance for Water Quality –based Decisions: The TMDL Process. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

US Environmental Protection Agency – Region 4 Atlanta, GA, 2001, Water Quality Analysis Simulation Program (WASP) Version 6.0 DRAFT: User's Manual By Tim A. Wool, Robert B. Ambrose, James L. Martin, Edward A. Comer